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**EFFECT OF HOT CLIMATE ON THE DIETARY PRACTICES OF BREASTFEEDING MOTHERS AND THE
HEALTH OUTCOMES ON THEIR BREASTFED CHILDREN (0-12 MONTHS) IN NIGERIA**

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ABSTRACT

This study employed convergent parallel mixed-methods design, integrating quantitative data from 200 breastfeeding mother–child pairs using rule of thumb for small scale studies to determine the sample size and systematic sampling method for samples selection at the study sites. The study samples were collected in two selected LGAs (Chanchaga and Bida) using Open Data Kit (ODK) tool at 4 focal health facilities in both LGAs (2 health facilities per LGA, 50 samples mother-child pair in each facility). Python programming language tool for regression analysis was further used to analyze the data set. For Qualitative insights, purposive sampling technique was employed in the selection. It involved Key Informant Interviews (KIIs) with nutrition focused health workers (3 per LGA) and Focused Group Discussions (FGDs) were employed with targeted community stakeholders in the different communities been served by the 4 selected focal health facilities in both LGAs. Traditional/religious leaders (12 per LGA) and fathers of breastfed children (12 per LGA) were involved. Thematic framework was further used to analyze the recorded and transcribed sessions. Quantitative findings revealed significant associations between heat-related factors and maternal dietary adaptations, particularly reduced intake of fruits, vegetables, and protein-rich foods ($p < 0.05$). These dietary changes were further linked to adverse child health outcomes, including poor weight gain and increased vulnerability to infections. Qualitative findings reinforced these results, highlighting climate-induced food insecurity, economic constraints, and sociocultural practices as key drivers of suboptimal nutrition and breastfeeding practices. The study contributes to growing literature on climate change and maternal-child health by demonstrating that heat exposure indirectly affects child health through maternal dietary pathways. Despite low explanatory power in some regression models, statistically significant behavioral adaptations underscore the importance of environmental stressors in shaping nutritional outcomes. The findings emphasize the need for climate-sensitive nutrition interventions, strengthened community health systems, and targeted policy responses to mitigate the effect of heat on vulnerable populations.

Keywords: Hot climate, breastfeeding, maternal nutrition, child health outcomes, climate change.

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1.0 INTRODUCTION:

1.1 Background

Climate change continues to pose a significant threat in Africa (Opoku SK et al., 2021), with heat waves increasing in severity and duration, especially in the Sahel (Sambou et al., 2021). Maternal and neonatal health is usually affected through the adverse effects of heat on preterm birth, stillbirth and maternal nutrition (Romero González AM et al., 2011). Baker RE et al., (2020) said Child wasting and malnutrition are expected to increase. According to Mundagowa PT et al., (2021), high temperatures may also reduce cognitive function and interfere with the activities of children, leading to a decline in their emotional health and well-being. Mothers may find it difficult to breastfeed their infants under extreme heat and may also change their behavior due to perceived risks to health.

In Nigeria, food security is influenced by internal and external crises, economic factors, and climate change. Food scarcity often led to malnutrition and incessant health challenges, especially for children (Risikat Dauda, 2023).

Niger State is a state in the North Central region of Nigeria, bordered to the east by Kaduna state and the Federal Capital Territory, to the north by Kebbi State and Zamfara State and to the south by Kogi and Kwara states, while its western border makes up part of the international border with Benin. It is the largest state in the country by area. The state capital is Minna, and the state is divided into 25 local government areas. The state has very warm climate with a yearly average of 34° Celsius. It is always warm or hot all year (Worlddata.info, 2022).

1.2 Statement of Problem

According to Niger State Planning Commission (2019): 'Malnutrition and nutrition related diseases remain a major public health concern in Niger State with high under-five mortality rate of 123 per 1,000 live births. Malnutrition is the major cause of 53% of these deaths. In Niger State, about half a million people representing 8.5% of the total population are undernourished'.

According to the 2014 SMART survey, breastfeeding is a common practice in Niger State, yet only 32.1% of children less than six months of age are exclusively breastfed (WHO recommendation). Infants should not be given water, juices, other milks, or complementary foods until six months of age. Niger State Planning Commission, (2019) confirmed that more than 70% of one million under-five deaths in Nigeria are caused by the poor feeding practices among the poor.

It then becomes urgent to understand how high temperatures impact maternal and child health nutrition. Sari Kovats et al., (2023) noted that millions of women live in hot or tropical climates, yet the role of environmental heat as a barrier to exclusive breastfeeding is rarely studied.

1.3 Purpose of the Study

- To significantly substantiate the effect of hot climate on the dietary choices/practices among breastfeeding mothers (18-45 years) of Nupe and Gbagyi ethnic groups in Chanchaga (Urban) and Bida (Rural) LGAs, in the hot climate region of Niger State, Nigeria.
- To understand how the mothers' dietary practice inadvertently affects their breastfed children (0-12 months') nutritional status and health outcomes.
- To provide evidence reports to the contributing factors of several diseases' outbreaks among children in hot climate regions.

1.4 Research Questions:

1. How do hot climate parameters affect availability of nutritious food and/or dietary practices of lactating mothers?
2. What impact does dietary practices of breastfeeding mothers have on the health outcomes of their breastfed children (0-12 months)?
3. What are the factors that promote disease outbreak among breast fed children (0-12 months)?

2.0 LITERATURE REVIEW

2.1 The Hot Climate Regions

A "hot climate" region is commonly defined as regions with high average temperatures, often exceeding 25°C. Usually hot climate areas do experience prolonged periods of hot weather, including heat waves, and are characterized by specific architectural and design features to cope with the heat (Hosseini Medi et al. 2010).

Characteristics of Hot Climates (Hosseini Medi et al. 2010):

- High Temperatures: Average temperatures are consistently high, often exceeding 25°C.
- Prolonged Hot Weather: Experience periods of hot weather, including heat waves.
- Humidity: Can be hot and humid or hot and dry, depending on the specific region.
- Sunlight: Receive abundant sunlight, leading to high solar radiation.
- Architectural Adaptations: Buildings are often designed to minimize heat gain, maximize natural ventilation, and provide shade.

2.2 Maternal and Child Health Nutrition in Niger State

As stated, before the report from the Niger State Planning Commission, 2019 stated that Malnutrition and nutrition related diseases has continued to be problems of public health importance in the State with high under-five mortality rate of 123 per 1,000 live births. Malnutrition is the major cause of 53% of these deaths.

In Niger State, about half a million people representing 8.5% of the total population are undernourished. The 2018 Nigeria Demographic and Health Survey (NDHS) reported 33.9% of children under five as being stunted, 16.2% as underweight, and 5.4% as wasted. In addition to inadequate basic protein and energy foods, the immediate causes of under-nutrition are inadequate micronutrients such as vitamin A, iodine, iron, and zinc. Almost 13% of women are anemic and 31% are iodine deficient, while close to 30% of children under five years are vitamin A deficient (VAD) and 20% are zinc deficient.

The report further stated that in addition to high rates of under-nutrition, the State is also witnessing a rise in the incidence of Diet Related Non-Communicable Diseases (DRNCD) such as Obesity, Diabetes Mellitus, and cardiovascular diseases. The 2013 NDHS reported that 18.1% of Women were overweight or obese, with the frequency increasing with age, education, and wealth. Globalization, urbanization, lifestyle transition, socio-cultural factors, and poor maternal, foetal and infant nutrition are all major causes of the increase in DRNCD. Underlying these problems of malnutrition are a number of issues such as poor maternal nutrition, suboptimal infant and young child feeding (IYCF) practices, inadequate health services and limited access to nutritious foods. According to the 2014 SMART survey, breastfeeding is a common practice in Niger State, yet only 32.1% of children less than six months of age are exclusively breastfed (WHO recommendation). Infants should not be given water, juices, other milks, or complementary foods until six months of age. SMART survey conducted in North Central Zone where Niger State belongs found that 32.1 % mothers of infants under six months were practicing exclusive breastfeeding (EBF).

For families that receive education surrounding appropriate IYCF lack access to affordable foods with sufficient quantities of micro and macronutrients required for a growing infant. These nutrients are lacking not only for the child, but also for the mother during pregnancy and breastfeeding. Foods currently in the market are relatively affordable for many of the poorest and most vulnerable. The poor feeding practices among the poor worsens high burden of disease with preventable or treatable infectious diseases such as malaria, pneumonia, diarrhoea, measles, and HIV/AIDS accounting for more than 70% of the estimated one million under-five deaths in Nigeria.

2.2.1 Nutrition in Emergencies:

Emergency nutrition interventions in Niger State remain inadequate. Natural and human-induced disasters, climate shocks, conflict, and insecurity are key drivers of hunger and malnutrition because people lose access to food production, markets, and purchasing. Essential services become overstretched; women, children under five, and the elderly constitute the largest share of vulnerable groups and therefore require immediate humanitarian support, particularly when displaced. Typically, financial, technical, and logistical capacities are persistently constrained.

Hence, nutrition concerns must be integrated into emergency preparedness and into emergency response and management frameworks (Niger State Planning Commission, 2019).

2.3 Community Engagement for Maternal and Child Health in Nigeria

The Community Health Influencers, Promoters, and Services (CHIPS) program is an initiative of the National Primary Health Care Development Agency (NPHCDA) and the Federal Government of Nigeria. The CHIPS program seeks to reduce maternal and child morbidity and mortality by improving access to primary healthcare services at the community level. It consolidates existing community-based structures—Village Health Workers (VHWs), Community Volunteers (CVs), and Volunteer Community Mobilisers (VCMs)—into a unified framework (Nigeria Health Watch, 2023).

Since implementation, multiple reports, notably by Nigeria Health Watch (2023), indicate persistent difficulties in securing state government financial commitment to the CHIPS program. This challenge became apparent when CHIPS agents and their supervisors did not receive their monthly stipends of ₦5,000 and ₦3,000, respectively, for nine months. The arrears were eventually cleared using funds from the Save One Million Lives Project in Nasarawa State, as reported by Dr. Absolum of the Nasarawa State Primary Health Care Development Agency (SPHCDA).

The resilience of CHIPS personnel has partly enabled notable progress in stimulating healthcare demand and improving service delivery in Nasarawa State. Nevertheless, funding constraints pose a substantial risk to agents' motivation and the program sustainability. Commitments made during training—including economic empowerment in recognition of their role and educational support for high-performing agents—remain unfulfilled. Given the critical function of CHIPS personnel in program success, sustained government commitment is essential to strengthen and ensure the long-term impact of the initiative in the state (Nigeria Health Watch, 2023).

2.4 World Health Organization (WHO) Recommended Food Groups for Breastfeeding Women

According to WHO (2001), the following food groups are the recommended foods for breastfeeding women:

2.4.1 Bread, cereals, pasta, rice and potato group – Mothers expected to eat 6-11 portions per day.

One serving from this food group is equivalent to one large slice of bread (approximately 30–40 g), three small crackers or sooshka, ½ cup of cooked pasta (macaroni, spaghetti, etc.), ½ cup of cooked cereal (rice, buckwheat, or oatmeal), ¾ cup (about 30 g) of ready-to-eat dry cereal, or one medium potato (100 g). Foods in this category serve as the primary source of dietary energy. They are also rich in essential micronutrients, including calcium, iron, zinc, and B-complex vitamins. Potatoes additionally provide a significant amount of vitamin C.

2.4.2 Vegetables and fruits group – Mothers expected to eat at least 5 portions per day (more than 400g).

One portion is defined as ½ cup (approximately 100 g) of vegetables such as carrots, onions, beets, leeks, or turnip, including those consumed in soups and stews; 1 cup of green leafy vegetables (cabbage, lettuce, spinach, broccoli, etc.); one medium tomato; ½ cup of sprouted beans; one medium piece of fruit (one apple, one pear, or two small plums); ½ cup (about 100 g) of fresh, preserved, or cooked berries; or 160 mL of 100% fruit or vegetable juice, for example, freshly squeezed carrot and orange blend. Vegetables and fruits constitute the principal source of numerous vitamins and minerals, notably folate and iron, which are critical for preventing anemia in pregnancy. Vitamins such as vitamin C are required by both mother and foetus and cannot be stored in the body. Therefore, daily consumption of adequate amounts of vegetables and fruits, particularly locally grown varieties, is essential.

2.4.3 Milk and dairy products group – Mothers expected to eat 3 portions a day.

One portion is defined as 1 cup (approximately 200 mL) of yogurt/kefir; 45 g of hard cheese, equivalent to the size of a matchbox; 1.5 cups (about 250 g) of cottage cheese; or 1 glass (300 mL) of milk. Dairy products represent one of the richest dietary sources of calcium. Calcium is essential for the development of healthy bones and teeth in the foetus and is critical during lactation for breast milk formation.

2.4.4 Fish, poultry, meat and bean group- aim to eat 2 portions a day.

One portion is defined as 1 cup (approximately 150–200 g) of cooked beans; two eggs; or 70–80 g of cooked lean fish, poultry, or meat. This food group comprises beans and lentils, fish, meat, poultry, eggs, and nuts, all of which are high in protein. Mothers are advised to consume a diverse range of these foods, with particular emphasis on beans, lentils, nuts, and fish, as they confer substantial health benefits for both mothers and their families. Meat, particularly organ meats such as liver and kidney, constitutes one of the richest sources of iron. Haem iron from animal sources is more bioavailable than non-haem iron from plant sources. However, liver consumption should be moderate to prevent excessive vitamin A intake.

2.4.5 Lard, butter, margarine, oils, sugar, sweets and salt group- use sparingly.

This food group comprises butter, margarine, oils, lard, sugars, candies, sweet desserts, pastries, and sweetened beverages—foods characterized by high fat, salt, and/or sugar content. These items are energy-dense but provide limited micronutrients. Consequently, consumption of these products should not displace more nutrient-rich foods from other food groups. Mothers are advised to substitute vegetable oils, such as olive, canola, or rapeseed oil, for animal fats where feasible; otherwise, total fat intake should be reduced. A diet low in total fat, and particularly low in animal fat, lowers the risk of certain cancers and cardiovascular disease—the leading causes of mortality in Europe. Salt intake should be moderate, not exceeding 6 g per day in total, with reduced use in

cooking and at the table, and limited consumption of salty or pickled foods. This practice decreases maternal risk of hypertension and associated complications. The use of iodized salt is recommended to ensure adequate iodine supply to the fetus during pregnancy and to the infant during lactation.

3.0 METHODOLOGY

This research study adopted convergent parallel design mixed method approach to assess the study objectives. The study comprises of quantitative and qualitative interviews.

3.1 Quantitative approach

The total sample size (200) for the survey was arrived at using rule of thumb for small scale studies (Memon, M. A. et. al., 2020).

$$n = (z^2 * p * q) / E^2$$

Where Z= 1.96 (for 95% confidence level), q=1-p, p=1-0.5, E=0.07

$$n = 0.9604 / 0.0049 = 196 \text{ (Rounded up to 200 for practical purposes)}$$

At the targeted 4 focal health facilities, a survey was conducted among the Nupe and Gwari breastfeeding mothers in each of the selected LGAs. The survey adopted Systematic sampling method for selection of the breastfeeding mothers at each health facility, to ensure high efficiency, low risk of data manipulation, and strong, even representation of the homogenous population (Dhanya Alex, 2024). Sample size at each facility (50) = Interval (1) of 4. Every forth eligible mother and their children were being selected for the survey.

In both LGAs, 200 Breastfeeding mothers were sampled within the ages 18-45 years. With the use of a configured Open Data Kit (ODK collect). In each LGA, survey questionnaires were administered on the different days of the children's routine immunization schedule at the four Governments' Focal Health Facilities serving breastfeeding mothers and their children in the LGAs.

3.2 Quantitative Survey Tool

The questionnaires included: (a) Basic background conditions such as age, gender, etc. (b) Dietary contents/practices/access (c) Thermal perception, behavior and control in respect to their dietary practices (d) Exclusive breastfeeding.

Simultaneously, the nutritional assessments of 200 breastfed children of already sampled mothers were examined, against the designated number that was assigned to their respective mothers already sampled and interviewed. Weight-for-age measurement approach was used for breastfed Children within 0-5 months and Middle Upper Arm Circumference (MUAC) tape for breastfed children within 6-12 months.

3.3 Qualitative Approach

In each LGA, purposive sampling technique was employed in the selection of respondents to provide evidence reports to the specific research needs/objectives (Tajik Omid et. al., 2025).

TABLE 1:

LGA	Settlement	Health Facility	Number of Traditional/ Religious Leaders	Number of Fathers	Number of Health Workers
Chanchaga	Old-airport	Old-airport Clinic	6	6	2
Chanchaga	Kpakungu	PHC Kpakungu	6	6	1
Bida	Kpotun Maiko	Kpotun Maiko PHC	6	6	2
Bida	Nnabantigi	Nnabantigi PHC	6	6	1

As seen in table 1, traditional leaders, religious leaders, fathers of households and community health workers that are nutrition focused were selected to enable them provide their view from practical/ lived experiences regarding the research questions.

In each LGA, Focused Group discussions were conducted differently, with Tradition Leaders, Religious Leaders and Fathers/Heads of Households of breastfed Children at the settlement. Usually, men provide communities/families where the mothers and children lives, and they are therefore capable enough to provide insight to family/community factors that affect the mothers/children dietary practices. Also, key informant interviews were conducted with the 2 LGAs Nutrition focal persons and 4 Nutrition desk officers at the health facilities in both LGAs, that serve the communities of respondents directly. This significantly help to understand the technical support/assistance from government and partners toward the community nutrition needs.

4.0 DATA ANALYSIS / RESULTS

4.1 Quantitative Analysis and Results

Table 2: SOCIO-DEMOGRAPHIC AND CHILDRENS' NUTRITIONAL CHARACTERISTICS

Number of children Sampled	200											
Number of Mothers Sampled	200											
Children Gender	Male						Female					
	108						92					
Children's Age (Months)	0 – 5						6- 12					
	101						99					
Mothers' Age (Years)	18 – 35						36- 40					
	188						12					
Children's Nutrition Assessment	0 – 5						6 – 12					
	S		M		N		S		M		N	
	14		9		78		19		14		66	
Children's Nutrition Assessment by Gender & Age	0 – 5						6- 12					
	Male			Female			Male			Female		
	S	M	N	S	M	N	S	M	N	S	M	N
	8	6	41	6	3	37	9	9	35	10	5	31

***S**- Severely Malnourished, **M**- Moderately Malnourished, **N**- Normal.

Table 2 presents the socio-demographic and nutritional characteristics of the 200 mother–child pairs included in the study. Of the children sampled, 108 (54.0%) were male and 92 (46.0%) were female, indicating a relatively balanced sex distribution. With respect to age, 101 (50.5%) of the children were aged 0–5 months, while 99 (49.5%) were aged 6–12 months.

The majority of mothers were between 18 and 35 years of age (188; 94.0%), while only 12 (6.0%) were aged between 36 and 40 years, suggesting a predominantly young maternal population.

In terms of nutritional status, weight for age was used to assess children 0-5 months and Middle Upper Arm Circumference (MUAC) for children 6-12 months (Ralston et. al., 2018). Notable differences were observed by age group. Among children aged 0–5 months, 14 (13.9%) were severely malnourished, 9 (8.9%) were moderately malnourished, and 78 (77.2%) had normal nutritional status. Among those aged 6–12 months, 19 (19.2%) were severely malnourished, 14

(14.1%) were moderately malnourished, and 66 (66.7%) were normal. This indicates a deterioration in nutritional status with increasing age, particularly during the period of complementary feeding.

Disaggregation by sex and age shows that both male and female children experience substantial levels of moderate and severe malnutrition across age groups, suggesting that vulnerability is widespread and not limited to one sex.

Python programming language tool for regression analysis was further utilized, leveraging its extensive stats models, which provided efficient and reliable implementations of various regression techniques to study relationships among variables (Oliphant, 2007; Seabold & Perktold, 2010).

Table 3: RELATIONSHIP BETWEEN HOT CLIMATE EFFECT AND MOTHERS DIETARY PRACTICE

		Hot climate rating	Hot climate exposure	Appetite affected by heat	Eat less during heat	Skip meals due to heat	Change meal due to heat	Decrease breast milk due to heat
Meals per day (numeric)	R square	0.0002	0.0128	0.0063	0.0037	0.0080	0.0059	0.0009
	coef	-0.0090	0.0341	-0.1150	-0.0792	-0.1140	0.0973	0.0384
	p value	0.8530	0.1102	0.2640	0.3894	0.2081	0.28	0.6793
Supplementary Food/Drink frequency	R square	0.0001	0.0050	0.0052	0.0003	0.0115	0.0155	0.0160
	coef	0.0015	0.0041	-0.0200	-0.0042	-0.0260	-0.0303	-0.0320
	p value	0.8680	0.3210	0.3097	0.8134	0.1309	0.0787	0.0832
Water frequency	R square	0.0047	0.0164	0.0017	0.0034	0.0038	0.0051	0.0054
	coef	-0.0030	-0.0021	-0.0030	-0.0042	-0.0040	-0.0051	0.0053
	p value	0.3338	0.0710	0.5598	0.4156	0.3864	0.3137	0.3160
Fruits frequency	R square	0.1224	0.0228	0.0201	0.1065	0.0910	0.1413	0.0453
	coef	-0.2590	-0.0499	0.2261	0.4625	0.4231	0.5219	0.2956
	p value	0.0001	0.0327	0.0450	0.0001	0.0001	0.0001	0.0033
Vegetables frequency	R square	0.1018	0.0076	0.0009	0.0577	0.0328	0.0636	0.0018
	coef	-0.1990	-0.0243	0.0404	0.2875	0.2144	0.2957	0.0501
	p value	0.0001	0.2190	0.6729	0.0006	0.0103	0.0003	0.5606
Protein foods frequency	R square	0.1254	0.0247	0.0004	0.0670	0.0297	0.1388	0.0545
	coef	-0.2760	-0.0547	0.0347	0.3875	0.2554	0.5465	0.3460
	p value	0.0001	0.0264	0.7716	0.0002	0.0146	0.0001	0.0012
Used Prescribed supplements (yes/no)	R square	0.0196	0.0259	0.0001	0.0082	0.0016	0.0364	0.0113
	coef	0.0437	0.0224	0.0041	-0.0542	-0.0240	-0.1119	-0.0630
	p value	0.0480	0.0229	0.9321	0.2025	0.5710	0.0068	0.1449

Table 3 presents the ordinary least squares (OLS) regression results examining the association between indicators of hot climate exposure (independent variables) and mothers' dietary practices (dependent variables).

The results show that several heat-related exposure variables were associated with changes in dietary practices, although the strength of these associations varied because many of these associations were not statistically significant ($p > 0.05$). Notably, changing meals due to hot climate conditions showed a statistically significant association ($p < 0.05$) with dietary practice outcomes, indicating that heat exposure significantly influences how meals are structured or substituted rather than simply reducing the number of meals consumed. Similarly, reduction in breastmilk production demonstrated a significant association ($p < 0.05$) with dietary practice indicators, highlighting breastfeeding disruption as a key behavioral response to heat stress.

Although the R^2 values across the models were relatively low, suggesting limited explanatory power, the presence of statistically significant coefficients for behavioral adaptation variables indicates that heat stress contributes meaningfully to alterations in maternal feeding patterns, particularly meal modification and breastfeeding practices due to low breastmilk production.

TABLE 4: Relationship Showing the Effect of Mother's Dietary Practice on Children's Health Outcomes

		Fever	Skin Rash	Diarrhea	Heat related illness	Poor Weight Gain
Meals per day (numeric)	R square	0.0173	0.0165	0.008	0.0027	0.007
	coef	-0.101	-0.0833	-0.048	-0.0241	-0.0423
	p value	0.0637	0.0697	0.21	0.4641	0.2373
Supplementary Food/Drink frequency	R square	0.0243	0.0042	0.005	0.0016	0.002
	coef	-0.624	0.2183	-0.201	0.0964	0.1168
	p value	0.0274	0.3636	0.314	0.574	0.5317
Water frequency	R square	0.0031	0.0014	8E-04	0.0005	0.0007
	coef	0.7739	0.4322	0.271	0.191	0.2312
	p value	0.4302	0.602	0.694	0.7468	0.7195
Fruits frequency	R square	0.0034	0.019	0.003	0.0003	0.0517
	coef	-0.041	-0.0817	0.027	-0.0074	-0.1045
	p value	0.4132	0.0514	0.446	0.8064	0.0012
Vegetables frequency	R square	0.0003	0.0007	0.009	0.0099	0.009
	coef	-0.014	-0.0183	-0.054	-0.0497	-0.0517
	p value	0.8159	0.7142	0.194	0.1617	0.1807
Protein foods frequency	R square	0.0087	0.0449	0.009	0.0271	0.0816
	coef	-0.062	-0.1187	-0.043	-0.0658	-0.1243
	p value	0.19	0.0026	0.192	0.0198	0.0001
Used Prescribed supplements (yes/no)	R square	0.0035	0.0014	0.016	0.0022	0.0019
	coef	-0.098	-0.0532	0.149	0.0468	-0.0474
	p value	0.4062	0.5934	0.071	0.5104	0.5402

Table 4 presents regression analysis results showing the relationship between maternal dietary practices (independent variables) and child health outcomes (dependent variables).

The findings indicate specific dietary components showed significant associations, P-values < 0.05. Supplementary feeding, fruit consumption and protein intake were in this group, with strong association in significant reduction in fever incidence, reduction in poor weight gain, including skin rash and heat-related illnesses. Other variables, including meal frequency, water intake, vegetable consumption, and prescribed supplements, showed no statistically significant relationships with child health outcomes.

Table 5: Relationship between Hot Climate Effects and Mothers-Children Socio-economic Resilience (Rural)

		RURAL					
		Fan/AC	Got support	Stays Indoor	Bathe Frequently	Employed	Formal Education
Hot climate rating	R square	0.0209	0.0171	0.464	0.0889	0.0105	0.0859
	coef	0.0209	0.0404	0.351	0.0834	-0.0494	-0.2563
	p value	0.317	0.3657	1E-04	0.0355	0.4782	0.0389
Hot climate exposure	R square	0.3132	0.0035	0.097	0.0646	0.0242	0.0614
	coef	-0.048	0.0108	-0.095	-0.0421	0.0444	0.1284
	p value	0.0001	0.6836	0.028	0.0749	0.2804	0.0828
Appetite affected by heat	R square	0.0064	0.0156	0.009	0.0001	0.0813	0.0067
	coef	-0.026	0.0877	-0.11	0.0044	-0.3114	-0.1623
	p value	0.5794	0.3875	0.518	0.962	0.0448	0.5724
Eat less during heat	R square	0.0072	0.039	0.168	0.0001	0.0002	0.035
	coef	-0.027	-0.1351	-0.468	-0.0042	-0.0166	0.3617
	p value	0.5588	0.169	0.003	0.963	0.9142	0.193
Skip meals due to heat	R square	0.0072	0.039	0.168	0.0001	0.0002	0.0581
	coef	-0.027	-0.1351	-0.468	-0.0042	-0.0166	0.4657
	p value	0.5588	0.169	0.003	0.963	0.9142	0.0918
Change meal to cope with heat	R square	0.016	0.0873	0.526	0.0127	0.0287	0.0846
	coef	-0.036	-0.1786	-0.731	-0.0617	0.1591	0.4968
	p value	0.3809	0.0372	1E-04	0.4351	0.2399	0.0404
Decrease breast milk production due to heat	R square	0.0148	0.0002	0.015	0.0103	0.0124	0.0396
	coef	0.0345	0.0082	-0.123	0.0558	-0.1051	-0.3415
	p value	0.4004	0.9258	0.4	0.4828	0.442	0.1662

Table 6: Relationship between Hot Climate Effects and Mothers-Children Socio-economic Resilience (Urban)

		Fan/AC	Got support	Stays Indoor	Bathe Frequently	Employed	Formal Education
Hot climate rating	R square	0.0001	0.0014	0.0557	0.5866	0.0060	0.0061
	coef	-0.0018	0.0117	0.1124	0.3746	-0.0313	-0.0734
	p value	0.9069	0.6876	0.0089	0.0001	0.3974	0.3942
Hot climate exposure	R square	0.0097	0.0192	0.1550	0.0002	0.0096	0.0255
	coef	-0.0067	-0.0181	-0.0766	-0.0031	0.0162	0.0616
	p value	0.2807	0.1283	0.0001	0.8667	0.2840	0.0787
Appetite affected by heat	R square	0.0148	0.0056	0.0171	0.1278	0.0005	0.0129
	coef	0.0407	0.0482	-0.1253	-0.3521	0.0175	-0.2155
	p value	0.1815	0.4115	0.1515	0.0001	0.8140	0.2133
Eat less during heat	R square	0.0020	0.0003	0.0943	0.3268	0.0074	0.0025
	coef	0.0140	-0.0097	-0.2732	-0.5221	0.0652	-0.0873
	p value	0.6213	0.8589	0.0006	0.0001	0.3449	0.5878
Skip meals due to heat	R square	0.0009	0.0038	0.0339	0.2463	0.0073	0.0014
	coef	0.0093	0.0374	-0.1654	-0.4577	0.0654	-0.0659
	p value	0.7443	0.4972	0.0423	0.0001	0.3482	0.6852
Change meal to cope with heat	R square	0.0001	0.0006	0.1715	0.4357	0.0153	0.0127
	coef	0.0038	0.015	-0.3812	-0.6240	0.0967	0.2055
	p value	0.8983	0.7904	0.0001	1.0000	0.1751	0.2164
Decrease breast milk production due to heat	R square	0.0006	0.0809	0.2191	0.3972	0.0007	0.0308
	coef	0.0078	-0.1722	-0.4228	-0.5844	0.0206	0.3139
	p value	0.7871	0.0015	0.0001	0.0001	0.7697	0.0532

Tables 5 and 6 present the regression analysis examining the combined effects of hot climate exposure, maternal dietary behavior, and socio-economic resilience in both rural and urban settings.

Across both settings, hot climate rating showed a strong and statistically significant positive association with staying indoors ($\beta = 0.3512$, $p = 0.0001$; $R^2 = 0.4636$) and a modest positive association with bathing frequently ($\beta = 0.0834$, $p = 0.0355$). Dietary responses to heat were also important predictors. Eating less and skipping meals due to heat were both significantly and negatively associated with staying indoors ($\beta = -0.4678$, $p = 0.0031$). In addition, changing meals to cope with heat showed a strong negative relationship with staying indoors ($\beta = -0.7305$, $p = 0.0001$),

a negative association with social support ($\beta = -0.1786$, $p = 0.0372$). Most other variables, including breast milk production, social support (in several models), and employment (in multiple instances), were not statistically significant ($p > 0.05$). The pattern of results is largely identical in both rural and urban samples, indicating that the influence of hot climate on behavioral and dietary coping mechanisms is consistent across settings.

4.2 Qualitative Analysis and Results:

Braun and Clarke's six-phase thematic analysis framework was adopted for the data set analysis (Ahmed et. al., 2025). The approach helped in identifying, analyzing, and interpreting patterns of meaning within the data set. The data comprised of audio recordings collected from community leaders, health care workers and fathers of targeted children at the different health facilities in both LGAs, as seen in Table 1. The data was collated, transcribed and then analyzed.

After the stages of analysis, six thematic areas stood out from the overall findings as follows:

Theme 1: Climate-Induced Food System Disruptions

Heat reduces crop yield and limits food storage. The popular practice of backyard gardens fails to thrive in hot weathers that runs through over seven months in a year, reducing the chances of the breastfeeding mothers to access quality and nutrient dense foods. A respondent noted that *'home grown crops in backyard gardens do not usually thrive.'* another person said, *'not many households have the means to store perishable foods, especially the proteins and vegetables and this affect the food supply.'*

Theme 2: Environmental Health Risks

Heat increases exposure to infectious diseases and worsens living conditions among already vulnerable children. It increases the child morbidity and mortality rate in hot climate setting. Two fathers, one in each of the LGAs claimed to have lost a child due to intense hot condition in their homes. A father said *'My Child once died because of too much heat,' 'I lost my baby due to the severe heat sometimes ago. I'm expecting another baby now'* both fathers disclosed.

Theme 3: Compromised Maternal Nutrition and Breastfeeding

Poor maternal diet leads to reduced milk production and quality that inadvertently cause low adherence to Exclusive Breastfeeding Feeding (EBF) practice among mothers. *'Poor eating habit/access to nutritious foods do cause insufficient breastmilk production for our mothers and has further impeded the rate of exclusive breastfeeding practice,'* a nutrition focal person noted during the interview session at the Health Facility.

Theme 4: Economic Constraints as a Mediator

Households face severe financial limitations, restricting access to available food. Most households' fathers who were the bread winner of their homes make less than 5 dollar a day, and couldn't afford the costly food commodities that are available. One of the fathers that was interviewed has this to say '*We plan for food based on daily income and most time, food is not available at home*'.

Theme 5: Sociocultural and Gender Dynamics

Cultural beliefs and male dominance shape feeding practices, often negatively. Over 90 % of the fathers interviewed claimed to determine the choice of food eaten in the family. '*I decide which food we are to eat based on my preference*' a father said. Cultural values that included the giving of certain herbal concoctions at certain age also discouraged the practice of Exclusive Breastfeeding (EBF), leaving a potential health risk for the children.

Theme 6: Weak Institutional Support

Limited government commitment and fragmented interventions at the grassroots hinder progress. This weakens community structures and demobilize the community leaders to take ownership of programs or lead meaningful partnership with the government to provide resilience to climate/food security crisis. '*No political will for nutrition programs at the LGA level. I have written to the LGA council chairman severally for support. My requests were never looked into or treated,*' were the words from one of the nutrition focal persons.

5.0 DISCUSSION, RECOMMENDATIONS AND CONCLUSION

5.1 Discussion:

This study offers empirical evidence linking hot climate conditions with maternal dietary practices and child health outcomes. The findings align with existing literature suggesting that environmental stressors, particularly heat exposure, significantly influence food systems, nutritional behaviors, and health outcomes (Baker et al., 2020; Kovats et al., 2023). The statistically significant reduction in consumption of fruits, vegetables, and protein-rich foods among breastfeeding mothers under heat stress conditions is consistent with studies showing that climate variability disrupts food availability and dietary diversity (FAO, 2021).

The regression results indicate that while overall explanatory power (R^2 values) is modest, specific behavioral adaptations—such as meal modification and reduced nutrient intake are statistically significant. This suggests that heat does not uniformly reduce food intake but rather alters dietary composition. Such findings corroborate previous research indicating that climate change affects food quality and diversity more than quantity (Myers et al., 2017).

Furthermore, the study highlights a critical pathway: maternal diet as a mediator between environmental stress and child health outcomes. Significant associations between protein intake and reduced incidence of skin rash, heat-related illnesses, and poor weight gain reinforce the importance of adequate maternal nutrition during lactation. This aligns with WHO (2001) recommendations and studies emphasizing the role of maternal diet in breast milk quality and infant health outcomes (Victora et al., 2016).

Qualitative findings deepen this understanding by revealing structural and socio-cultural barriers. Climate-induced agricultural disruptions, limited food storage, and economic hardship reduce access to nutrient-dense foods. Additionally, gender dynamics and cultural beliefs influence feeding practices, often undermining exclusive breastfeeding. These findings are consistent with UNICEF (2020), which highlights the intersection of poverty, culture, and nutrition in low-resource settings.

The study also identifies weak institutional support as a significant constraint. Limited government investment in nutrition programs and weak community engagement hinder effective responses to climate-related health risks. This supports existing evidence that governance and policy gaps exacerbate vulnerability in climate-sensitive regions (IPCC, 2022).

However, the study has limitations. The relatively small sample size and low R^2 values suggest that other unmeasured variables may influence outcomes. Additionally, reliance on self-reported dietary practices may introduce recall bias. Despite these limitations, the mixed-methods approach strengthens the validity of findings through triangulation of data sources.

Overall, this study contributes to the growing body of evidence that climate change is not only an environmental issue but also a critical determinant of nutrition and health. It underscores the need for integrated approaches that address environmental, economic, and socio-cultural factors simultaneously.

5.2 Recommendations:

1. **Climate-Sensitive Nutrition Programs:** NGOs and CBOs should develop and implement targeted interventions that address the nutritional needs of breastfeeding mothers in hot climates, including supplementation and food support programs.
2. **Strengthening Food Systems:** The Government at all levels should promote climate-resilient agriculture and improve food storage infrastructure to ensure year-round access to nutrient-dense and affordable foods for the communities, and also prioritize women dietary needs. These and other innovations that promote community-based nutrition solutions should be encouraged and supported at the grassroots/community level.

3. **Community Education:** Government/Community engagement NGOs/CBOs should Increase awareness of optimal breastfeeding and dietary practices through culturally sensitive community engagement strategies. This should also involve proper sensitization and mobilization of fathers of breastfed children in facility/community health talks on the right dietary practice for their wives.
4. **Economic Empowerment:** Government and INGOs should support income-generating activities for households, especially women, to improve food security and access to diverse diets.
5. **Policy and Institutional Support:** INGOs and Government commitment should be strengthened for nutrition programs, particularly at the local government level, and ensure sustainable funding for local initiatives and Community Based Organizations (CBOs).
6. **Advocacy Visits and Stakeholder Engagements:** Findings from this research should be further reported to the State, LGAs and development partners through advocacy visits and stakeholder engagement meetings. This will encourage collaboration and strengthen evidences for policy engagements and generate insightful solutions that could solve nutrition-centered challenges in grassroots communities. It will also create a practical pathway to drive research findings into possible policy actions, right from bottom (homes) to top (Government).
7. **Further Research:** Funding should be provided by INGOs/Government to conduct longitudinal studies with larger sample sizes to better understand causal relationships and improve the robustness of findings.

5.3 CONCLUSION

The study demonstrates that hot climate conditions significantly influence maternal dietary practices, which in turn affect the health outcomes of breastfed children. While the direct statistical effects of heat exposure appear modest, the indirect effects through dietary changes are substantial and meaningful, with impact on the quality and quantity of breast milk production. The findings highlight that climate change exacerbates existing vulnerabilities in maternal and child nutrition, particularly in resource-constrained settings like Niger State.

The integration of quantitative and qualitative data provides a comprehensive understanding of the issue, revealing that environmental, economic, and socio-cultural factors collectively shape health outcomes of both mothers and their children.

While the Government/INGOs support the grassroots health facilities with supplementary feeding for mothers and their children, they were never enough as the challenges were systemic, stemming from poor community support/ownership for proper nutrition.

A great insight these findings provide is also the mediation of nutrition between hot climate and community herd immunity. It shows significantly that with poor nutrition for mothers and children, communities become vulnerable and the more vulnerable members, especially under five children are willed to even the least virulent disease-causing organism. This inadvertently suppresses herd immunity in such communities, especially among breastfeeding children. An eye-opener to why Vaccine Preventable Diseases (VPDs) remain recurrent after several routine and campaign vaccination activities.

Addressing these challenges requires a multi-sectoral approach that prioritizes both immediate nutritional needs and long-term climate resilience.

Necessary and important actions for further research to further understand underpinning causes with a larger population should be employed, while advocacy and multi-sectoral engagements at the higher and lower levels of governments and leadership should kick start as way forwards to quickly mitigate challenges.

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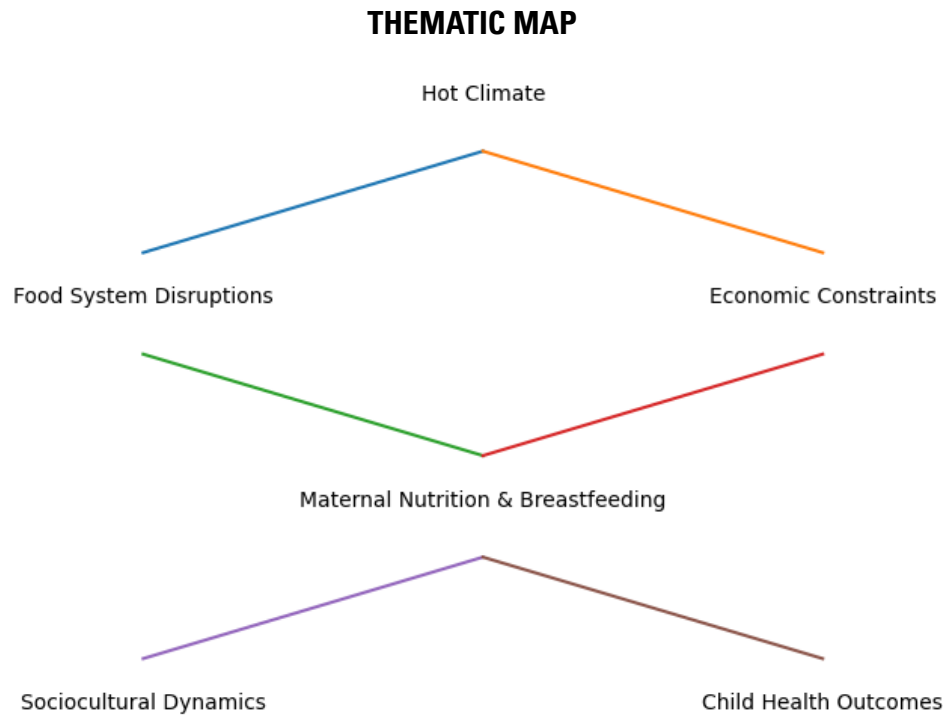
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APPENDIX:

Appendix 1:



Explanation:

The thematic map visually represents the interconnected pathways through which hot climate influences maternal and child health outcomes. At the top, 'Hot Climate' acts as the primary driver, influencing food system disruptions and economic constraints. These in turn affect maternal nutrition and breastfeeding practices, which serve as the central pathway. Sociocultural dynamics further shape these practices, while the combined effects ultimately lead to adverse child health outcomes.

Appendix 2:

Table of Themes, Subthemes and Illustrative Quotes:

Theme	Subthemes	Illustrative Quote
Food System Disruptions	Crop failure, food scarcity	home grown crops do not thrive
Economic Constraints	High food cost, low income	There is food but no money to buy
Maternal Nutrition	Poor diet, low milk production	Mothers complain of not feeding well
Sociocultural Dynamics	Fathers' dominance, beliefs	I decide for the family diet
Health Risks	Disease outbreaks, dehydration	Hot weather increases chance of disease outbreak
Institutional Weakness	Poor policy support	No grassroots political will for nutrition programs